Appendix G

Commercial and Recreational Fishing and Kelp Harvesting Resources

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G.0 APPENDIX G

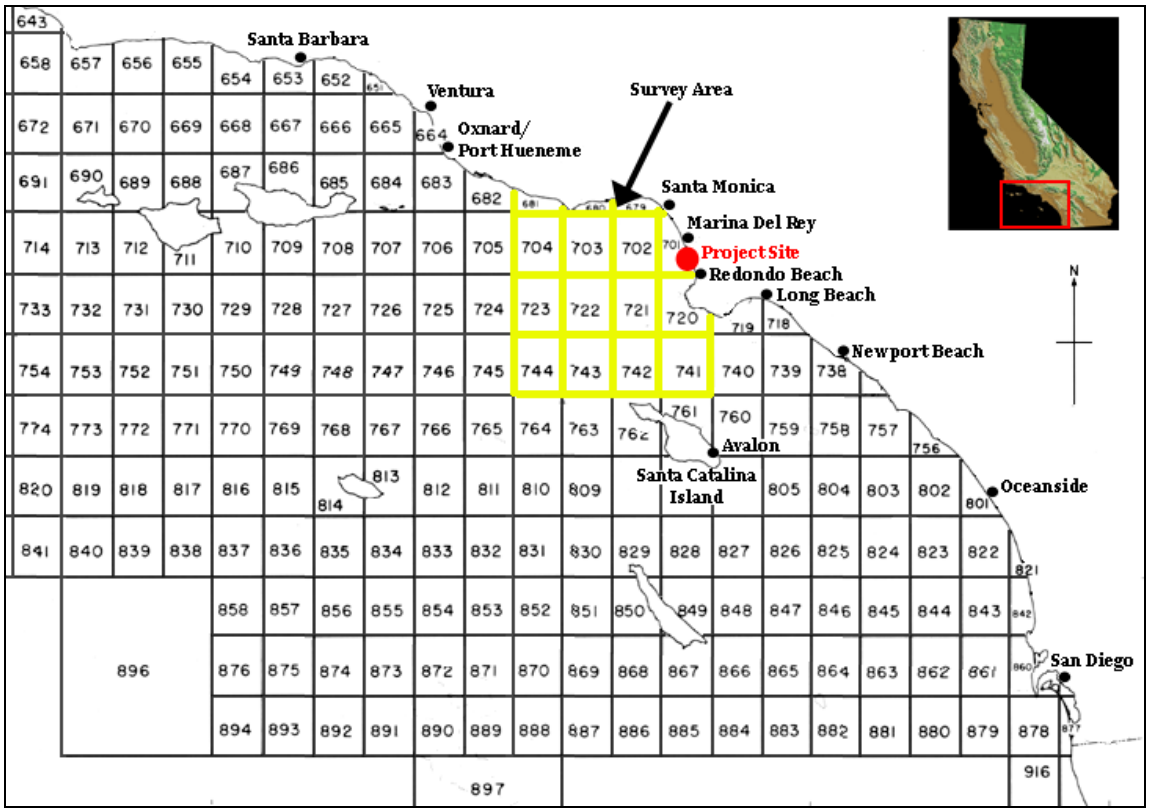
G.1 COMMERCIAL AND RECREATIONAL FISHING AND KELP HARVESTING RESOURCES

Kelp harvesting and commercial and recreational fishing activities occur throughout the Project area, and contribute to the economic and recreational quality of the region.

Commercial Fishing

An analysis of fishery data collected within statistical fish-block units around the Project area for the 12-year period from 1996 to 2007 forms the basis for the following summary of commercial fishing (Figure G-1).

Figure G-1
Locations of CDFG Fish Blocks within the Southern California Bight



Fish blocks are used by the California Department of Fish and Game (CDFG) (2006a) to organize and report commercial and recreational harvest of marine organisms off the California coast. Monthly catch is reported within rectangular fish blocks nominally covering 100 square miles (9 by 11 mile rectangular areas). However, where the coastline bisects fish blocks, they can cover a much smaller ocean area. The 16 Fish Blocks identified in yellow in Figure G-1 encompasses an area of approximately 2,400 square miles. The offshore portion of the Project area is located within Block 701.

Over the 12-year period, 197 different fish taxa were harvested commercially in the 16-block study region encompassing the Santa Monica Bay area. Overall, the 169,017-ton harvest was valued at $40.19 million (M) (Table G-1). Over 94 percent of the total weight and 84 percent of the value of the catch were landed at 11 ports within Los Angeles County (San Pedro, Terminal Island, Redondo Beach, Marina Del Rey, Avalon, Long Beach, Wilmington, Santa Monica, Los Angeles, Malibu, and Hermosa Beach). Nearly all the remaining fish caught in the survey blocks were landed at Port Hueneme, Oxnard, or Ventura harbors to the north.

Regional Fisheries

A few major taxonomic groups represented the bulk of the commercial catch in the region (Table G-1). For example, sardines (Clupeidae*)* represented over half of the biomass and one fifth of the dollar value of the catch. Of the other major taxonomic groups, squid (order Teuthida), mackerel (Scombridae), anchovy (Engraulidae), and urchins (*Strongylocentrotus spp)* made up most (40 percent) of the remaining biomass. Sardines and chub (Pacific) mackerel (*Scomber japonicus*) have been important catches from the Palos Verdes Shelf and Santa Monica Bay for several decades (MBC 1985; Stull et al. 1987). Due to overfishing, a moratorium on fishing for Pacific sardine and chub mackerel was implemented in the mid-1970s. However, by 1975, the chub mackerel population had recovered and by 1985 it was the dominant fishery in California, with 83 percent of the catch originating in southern California (CDFG 1986, 1987). In recent years, market squid (*Loligo opalescens*) has become one of the most prominent fisheries in California, and frequently ranked as the state's largest commercial fishery and highest edible fishery export.

Although the commercial catch in the region was dominated in weight by only a few taxa, pound for pound, the value of individual fish taxa varied significantly. Specifically, more expensive taxa ranked higher in total dollar value than in total biomass. For

example, urchin, shrimp (*Crago* spp.), spiny lobster (*Panulirus interruptus)*, halibut (*Hippoglossus stenolepis)*, and crab (*Cancer* spp.) represented 40 percent of the value of the non-squid fish harvest, while accounting for only three percent of the non-squid biomass.

Table G-1
Ranking of Commercial Fisheries in the 16-Block Survey Area

Total Pounds (Tons)			Dollar Value (M)		
Fishery	**Weight**	**Percent**	**Fishery**	**$ Value**	**Percent**
Sardine	98,132.3	58.1%	Squid	13.83	34.4%
Squid	45,426.3	26.9%	Sardine	8.12	20.2%
Mackerel	15,171.1	9.0%	Urchin	4.51	11.2%
Anchovy	4,577.9	2.7%	Lobster	3.95	9.8%
Urchin	2,551.8	1.5%	Rockfish	2.43	6.0%
Tuna	653.1	0.4%	Mackerel	1.96	4.9%
Rockfish	550.7	0.3%	Crab	1.23	3.1%
Crab	450.2	0.3%	Sablefish	0.55	1.4%
Lobster	251.9	0.1%	Shrimp	0.49	1.2%
Sablefish	245.5	0.1%	Halibut	0.45	1.1%
Barracuda	163.0	0.1%	Anchovy	0.38	0.9%
Sea Cucumber	163.0	0.1%	Tuna	0.38	0.9%
Shark	116.5	0.1%	Shark	0.29	0.7%
Shrimp	80.2	0.0%	Sea Cucumber	0.28	0.7%
Other fish	77.8	0.0%	Seabass	0.26	0.6%
Halibut	69.4	0.0%	Sheephead	0.24	0.6%
Sheephead	66.4	0.0%	Other invertebrate	0.20	0.5%
Seabass	50.0	0.0%	Swordfish	0.18	0.5%
Herring	44.3	0.0%	Barracuda	0.14	0.4%
Snail	27.9	0.0%	Other fish	0.14	0.4%
Other taxa	148.5	0.1%	Other taxa	0.17	0.5%
Grand Total	**169,017.9**	**100.0%**	**Grand Total**	**40.19**	**100.0%**

Notes: 1 ton = 0.9 metric ton; M= millions of dollars.

Source: CDFG 2007a.

Table G-2 provides information on how the catch from the 16 survey blocks was distributed among the local ports each year. It shows that the bulk of the catch (159,500 tons and $34 M) from the study blocks was landed at 'home' ports within the Long Beach area, predominately due to their proximity to these fishing grounds. The San Diego ports represent a correspondingly smaller portion (101 tons and $0.4 M) of the catch from these survey blocks due to their greater distance from the fishing area.

Table G-2
Annual Summary of Commercial Fish Landings by Port

	Ventura		Port Hueneme[1]		Long Beach[2]		San Diego[3]	
Year	Weight (tons)	Value (M)	Weight (tons)	Value (M)	Weight (tons)	Value (M)	Weight (tons)	Value (M)
1996	57	0.07	497	0.39	19,500	3.54	13	0.04
1997	265	0.04	222	0.29	10,069	1.98	10	0.05
1998	7	0.00	23	0.07	22,580	2.66	1	0.01
1999	36	0.05	410	0.32	13,343	1.84	10	0.05
2000	1,709	0.34	2,619	0.96	29,641	6.23	3	0.02
2001	61	0.03	1,249	0.65	9,947	2.07	9	0.03
2002	1	0.01	212	0.38	11,533	1.94	6	0.04
2003	96	0.04	258	0.38	6,379	2.28	29	0.03
2004	62	0.04	375	0.38	9,896	2.36	9	0.09
2005	18	0.01	224	0.25	7,726	2.23	4	0.02
2006	80	0.13	43	0.12	6,414	1.93	5	0.05
2007	152	0.17	527	0.36	12,498	4.80	3	0.01
Total	**2,545**	**0.94**	**6,660**	**4.57**	**159,524**	**33.86**	**101**	**0.43**

Notes: [1] Port Hueneme values are taken from the Oxnard and Port Hueneme ports.

[2] Long Beach values are taken from Los Angeles and Long Beach ports.

[3] San Diego values are comprised of data from Orange County and San Diego ports.

Source: CDFG 2006a

Yearly fluctuations in the volume and dollar value of the catch landed at each of the five port complexes over the last decade are also apparent in Table G-2. Although Long Beach consistently ranked first in weight and value of commercial catch from the 16-block study region every year, the weight and value of the catch varied dramatically from year to year. However, much of the variation observed in Table G-2 can be ascribed to the abundance and availability of market squid within the region.

For example, in addition to comprising a substantial portion (23 percent by weight and 36 percent by value) of the overall catch landed at the Long Beach ports, market squid overwhelmingly dominate the landings at the Hueneme/Oxnard and Ventura (93.8 percent by weight and 57.6 percent by value) harbors. At Port Hueneme the squid catch has comprised well over half of both the annual tonnage (66.5 percent) and value (66.9 percent) over the past decade (Table G-3).

Table G-3
Ranking of Commercial Fish Landings in the 16-Block Survey Area

	Ventura		Port Hueneme[1]		Long Beach[2]		San Diego	
Rank	**Weight (tons)**	**Value ($M)**	**Weight (tons)**	**Value ($M)**	**Weight (tons)**	**Value ($M)**	**Weight (tons)**	**Value ($M)**
1	Squid (2,409.2)	Squid (0.5)	Squid (5,035.9)	Urchin (2.2)	Sardine (98,050.7)	Squid (12.1)	Sablefish (27.5)	Sablefish (0.1)
2	Urchin (38.1)	Lobster (0.2)	Urchin (1,221.9)	Squid (1.2)	Squid (37,908.5)	Sardine (8.1)	Squid (24.3)	Rockfish (0.1)
3	Rockfish (29.8)	Urchin (0.1)	Rockfish (123.0)	Lobster (0.5)	Mackerel (15,167.7)	Lobster (3.2)	Rockfish (18.3)	Swordfish (0.1)
4	Shrimp (19.9)	Shrimp (0.1)	Anchovy (80.5)	Rockfish (0.4)	Anchovy (4,497.5)	Urchin (2.2)	Swordfish (7.6)	Shrimp (0.1)
5	Sardine (10.1)	Rockfish -	Sardine (71.6)	Sablefish (0.1)	Urchin (1,207.5)	Mackerel (2.0)	Crab (5.8)	Lobster -
6	Cucumber (10.0)	Abalone -	Sablefish (50.3)	Sheephead (0.1)	Tuna (6,51.4)	Rockfish (1.8)	Shrimp (3.8)	Halibut -
7	Lobster (9.2)	Halibut -	Lobster (29.4)	Crab -	Crab (4,21.4)	Crab (1.2)	Lobster (3.2)	Squid -
8	Seabass (2.8)	Seabass -	Cucumber (15.4)	Cucumber -	Rockfish (372.5)	Halibut (0.4)	Urchin (2.9)	Crab -
9	Mackerel (2.5)	Sheephead -	Crab (14.6)	Halibut -	Lobster (206.9)	Tuna (0.4)	Halibut (1.5)	Sheephead -
10	Halibut (1.9)	Cucumber -	Sheephead (9.2)	Shrimp -	Sablefish (166.7)	Anchovy (0.4)	Sheephead (1.3)	Urchin -
other taxa	(10.2)	-	(7.8)	-	(792.3)	(1.9)	(4.4)	-
Total	**2,544.5**	**0.9**	**6,659.5**	**4.6**	**159,443.3**	**33.8**	**100.8**	**0.4**

Notes: [1] Port Hueneme values are taken from the Oxnard and Port Hueneme ports.

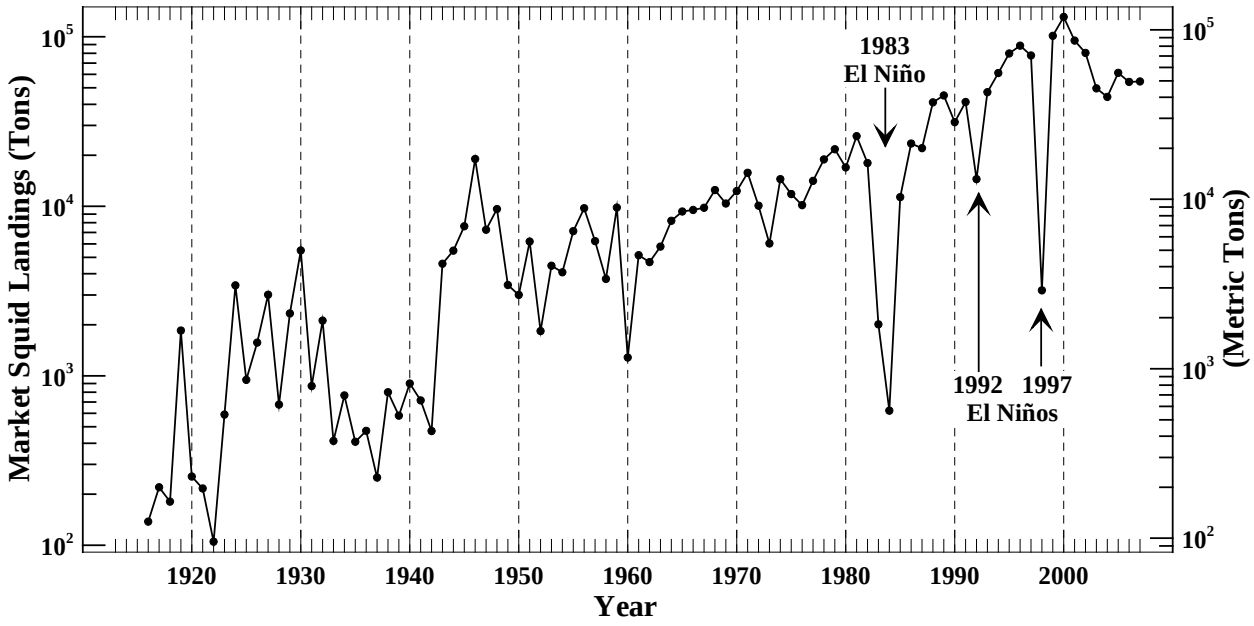
[2] Long Beach values are taken from Los Angeles and Long Beach ports.

[3] San Diego values are comprised of data from Orange County and San Diego ports.

Source: CDFG 2006a

The annual squid catch offshore California has increased exponentially, doubling approximately every 9 years from 1961, when it was 5,000 tons to 2000, when the catch exceeded 100,000 tons (Figure G-2). This fishery is highly localized, concentrating on known squid spawning grounds around the Channel Islands, Santa Monica Bay, and southern Monterey Bay. Significant declines in catch volumes occurred during major El Niño events in 1983, 1992, and 1997. For example, during the strong El Nino of 1997-1998, commercial landings within the state plummeted to less than 2 million pounds.

Figure G-2
Annual Commercial Squid Landings in Southern California



Source: CDFG 2007a.

Prior to April 1998, the market squid fishery was an unregulated, open access fishery (CDFG, 2001). To better control this rapidly expanding fishery, the CDFG instituted new regulations, such as the restricted use of lights, documentation of fishing activity in logbooks, weekend closures, light-boat shielding, and wattage restrictions. Between 2000 and 2007, most of the squid landed near the project area were close to shore. This area could be impacted by an oil spill associated with the proposed project as described predicted by spill modeling in Section 4.1, System Safety and Reliability.

Site-Specific Fisheries

As described above, the commercial fishery fluctuates during El Niño events, and landings differ among ports for individual taxonomic groups. In addition, the catch is not uniformly distributed across the 16-block study region. Instead, it is heavily weighted toward the region around Palos Verdes point (Block 720 in Figure G-1). Over 56 percent of the total weight and 39 percent of the total value of the commercial catch within the 16-block study area were derived from that one fish block.

In contrast, Fish Block 701, which encompasses the Project area, accounts for only one-half percent of the commercial landings in the 16-block study region (Table G-4). As with the region as a whole, the catch from Block 701 was dominated in both weight and value by market squid. Squid comprised over 78 percent of the total biomass and

62 percent of the recovered value from the block. Together with sardines and urchins they comprised over 97 percent of the biomass harvested from the block.

Table G-4
Ranking of Top 15 Commercial Fisheries Operating in Fish Block 701

Fishery	Weight (Tons)		Fishery	Value ($M)
Squid	728.5		Squid	0.20
Sardine	166.5		Halibut	0.03
Urchin	12.3		Sardine	0.02
Shark	9.3		Shark	0.02
Halibut	4.7		Urchin	0.02
Anchovy	3.6		Lobster	0.01
Sea Cucumber	1.6		Crab	<0.01
Mackerel	1.5		Rockfish	<0.01
Crab	1.3		Seabass	<0.01
Barracuda	1.0		Sea Cucumber	<0.01
Rockfish	0.9		Barracuda	<0.01
Seabass	0.6		Other invertebrates	<0.01
Lobster	0.5		Sheephead	<0.01
Surfperch	0.5		Anchovy	<0.01
Mussel	0.5		Surfperch	<0.01
Total	**933.2**		**Total**	**0.32**

Gear

Commercial fishermen may fish multiple fisheries throughout the year depending on the fish availability, market demand, prices, and harvest regulations such as catch quotas set by the CDFG. For example, although the season for pelagic fishes is open all year, the CDFG sets catch quotas. When quotas are filled, the fishery is over for that year unless an extended quota is subsequently issued. Consequently, within the 16-block study area, commercial fishers utilize fishing gear capable of targeting multiple species (MMS 2005b) including: 1) seines for coastal pelagics such as sardine, northern anchovy, mackerel, and market squid; 2) trawls for shrimp, sole, flounder, and halibut; 3) hook and line/longlines for rockfish and other rocky outcrop fish; 4) traps for crab and lobster; 5) drift/set gillnets for shark and swordfish; and, 6) trolls for albacore and salmon.

Seiners targeting squid were responsible for landing the largest biomass within the 16-block study area, and accounted for the largest catch within the block (Block 701)

encompassing the Project area (Table G-5). Although there are several variations, seines are generally used to encircle schools of pelagic fish species. Seiners generally traverse an area along an erratic course searching for schools on sonar. Once a school is found, a net is laid out on the surface to encircle the prey species. Floats along the upper lead line keep the top end of the net at the water surface. Metal rings are sewn along the bottom edge and a cable is passed through the rings. When the cable is drawn tight, the net "purses" (Fields, 1965). Squid are landed exclusively by purse seines (Vojkovich, 1998). In prior years, high-intensity lamps were used to attract squid to the surface and a brail net was used to scoop the squid onto the ship (Kato and Hardwick, 1975). Brail vessels could not compete with the more efficient seiners, however, and are now rarely used (Vojkovich, 1998).

Table G-5
Comparison of Commercial Fish Landings as a Function of Gear Type

Weight (Tons)				Value ($M)		
Gear	**Region**	**Block 701**		**Gear**	**Region**	**Block 701**
Seine	160,432.5	616.1		Seine	23.37	0.12
Net	3,066.4	282.7		Trap	6.00	0.01
Diving	2,668.3	14.0		Diving	4.87	0.03
Hook & Line	932.4	16.0		Hook & Line	3.19	0.06
Trap	883.6	2.1		Net	1.23	0.10
Gill Net	415.5	3.1		Gill Net	1.00	0.01
Other	251.8	0.7		Trawl	0.34	0.00
Trawl	154.0	0.1		Harpoon	0.14	0.00
Troll	92.6	0.0		Troll	0.03	0.00
Harpoon	55.4	0.0		Other	0.03	0.00
Grand Total	**169,017.9**	**934.6**		**Grand Total**	**40.19**	**0.33**

Notes: data from 1996-2007
Source: CDFG 2009

Gill and other nets are also used within the 16-block study area and account for the second largest catch and value within Block 701. Gillnet fishing has increased in importance in California, although it is not allowed in the inner part of Santa Monica Bay. Gill nets consist of a vertical wall of netting. Weights and anchors on the bottom horizontal line anchor the bottom portion of the net to the seafloor while a series of floats on the top lead line lift the upper portion of the net towards the ocean surface. Gill nets are used for a wide variety of fish including halibut, yellowtail, and rockfish. White croaker are targeted with set gillnet fishing on the Palos Verdes Shelf; and the catch is sold fresh, primarily to ethnic markets in nearby Los Angeles.

Several fishing methods that use hooks attached to lines are utilized in the area for specific fisheries. This technique accounts for the third largest biomass and value extracted from Block 701 and is important throughout the 16-block study region. Vertical longlines employ a series of hooks attached to a weighted line and are suspended vertically in the water column. Vertical longlining is commonly used to fish for rockfish over hard-bottom structures. Horizontal bottom longlines are similar to vertical longlines except that the hooks lay on the seafloor. Weighted ends keep the line on the seafloor. Horizontal longlines are used to catch bottom fish such as halibut and sole.

Diving has also been a significant commercial fishery within the 16-block study area, particularly in terms of the value of the catch. Diving accounted for nearly eight percent of the value harvested within Block 701 while compromising 1.5 percent of the harvested biomass. Throughout the Santa Monica Bay most of the commercial diving occurs along the Palos Verdes Point. Commercial divers primarily harvest sea urchins, although a significant amount of sea cucumbers and other invertebrates were also harvested within the study region.

Trapping is widely used within the 16-block study area and within Block 701. Pots and traps come in a variety of shapes and sizes. In the project area, they are used primarily to capture crabs, lobsters, and to a lesser extent, prawns and certain fish species. Typically, several pots or traps are attached to a heavy groundline with an anchor or heavy weights attached at both ends. The ends of the line are connected to a surface buoy containing markers such as flags, radar reflectors, or even lights. Crab pots in particular are set in hard-bottom habitats. They can be set individually or in groups attached to a common groundline. During installation and retrieval of traps and pots, they can be dragged several meters along the bottom. Pots and traps are generally used at water depths less than 200 meters near hard bottom habitat or along edges of canyons. However, pot fishing for sablefish can occur at depths up to 500 meters along the edge of the continental shelf.

Trawlers are responsible for extracting a smaller value from the survey region and, in particular, Block 701, principally from shrimp. Trawls can be conducted either in midwater or along the seafloor. Bottom trawls occur most often in the study region. They are designed to maintain contact with the seafloor. Although there are several types of trawls depending on the species fished, in their most basic form they are funnel-shaped nets that are towed over the seafloor. As they are towed over the seafloor surface, the rope, chain, or line (e.g., tickler chain, bridles, etc.) that precedes

the net opening scare prey up off the ocean bottom. As the trawl is towed forward, prey is captured in the netting that follows. The opening of the trawl is maintained by a headrope with floats on the top, a footrope with weights on the bottom, and doors to each side that spread the net horizontally on the seafloor. Trawling varies seasonally in the 16-block study region.

Within Block 701, trawls and traps were predominantly used to catch the non-finfish, such as urchin, shrimp, lobster, and crab that have historically been the most profitable catch at that site over the past decade.

Trolling consists of towing a baited hook or lure behind a boat. Pelagic fish such as salmon or albacore tuna are the primary target catch in the study region. Trolling commonly occurs in the water column high off the bottom, but in certain years, trolling for salmon can occur close to seafloor.

Recreational Fishing

The following summary of recreational fishing in the Project area is based on information gathered as part of the California Recreational Fisheries Survey (CRFS). The CRFS collects data on California's marine recreational fisheries, and estimates the catch and effort of anglers fishing for marine finfish in California. The survey was instituted in January 2004, and is a collaborative effort between the CDFG and the Pacific States Marine Fisheries Commission (PSMFC) with funding from state and federal sources.

Close to 200 fish species are recreationally fished within the Santa Monica Bay area. Recreational fishing activities in the Santa Monica Bay area occur from a variety of platforms, including the shoreline (e.g., beaches, jetties, breakwaters), piers, and private and charter vessels. Divers use spears or their hands in shallow water to harvest fish and invertebrates (Squire and Smith 1977). Because reliable recreational fish landing data specific to the Project area are not available, the recreational fishing effort was analyzed for the region comprising the coastlines of San Diego, Orange, and Los Angeles Counties. Table G-6 provides a summary of the top 10 fish species caught in nearshore (less than 3 nautical miles) coastal waters throughout this region over the past five years. The numbers provided in the table are conservative estimates of catch landings because reporting is voluntary, and many catches go unreported.

Table G-6
Top 10 Individual Fish Species Recreationally Harvested Within 3 Nautical Miles of Shore in Southern California from 2004 to 2009

Taxon	Reported Catch[3] (# of fish)	
	2004-2009	2009
Pacific Mackerel (*Scomber japonicas*)	3955	475
Pacific Sardine (*Sardinops sagax caerulea*)	1877	361
Barred Sand Bass (*Paralabrax nebulifer*)	1218	66
Kelp Bass (*Paralabrax clathratus*)	1098	108
Pacific Bonito (*Sarda chiliensis lineolata)*	888	20
Barred Surfperch (*Amphistichus argenteus*)	837	72
Queenfish (*Seriphus politus*)	701	61
Jacksmelt (*Atherinopsis californiensis*)	583	78
Yellowfin Croaker (*Umbrina roncador*)	402	73
California Scorpionfish (*Scorpaena guttata*)	328	33

Notes: [3] Total fish counts for San Diego to Los Angeles areas as defined by RecFIN database.

Source: Pacific States Marine Fisheries Commission 2010.

Within the Santa Monica Bay, the area from Point Dume to Playa del Rey is fished mainly for California halibut, kelp bass (*Paralabrax clathratus*), barred sand bass (*Paralabrax nebulifer*), rockfishes, chub mackerel, Pacific bonito (*Sarda chiliensis*), white seabass (*Atractoscion nobilis*), and Pacific barracuda (*Sphyraena argentea*). The sandy shelf extending from Playa del Rey to Hermosa Beach, is fished mainly for pelagic species such as bonito and barracuda, and bottom dwelling species, such as California halibut (*Hippoglossus stenolepis*). In contrast, vermilion rockfish (*Sebastes miniatus*), bocaccio (*Sebastodes paucispinus*), and chilipepper rockfish (*Sebastes goodei*) are taken along the Redondo and Santa Monica Submarine Canyons and along the shelf off Hermosa Beach. Vermilion rockfish, olive rockfish, and bocaccio are caught in the rocky substrates off Point Dume (Squire and Smith 1977).

Several fishes also live near the shore or in the surf zone in the Santa Monica Bay, where they are commonly caught from piers or the beach. These include California corbina (*Menticirrhus undulates*), barred surfperch (*Amphistichus argenteus*), and shovelnose guitarfish (*Rhinobatos productus*). California halibut are frequently caught from shore as well, particularly when they move inshore to feed on California grunion (*Leuresthes tenuis*) which come ashore to spawn on the sandy beaches within the Santa Monica Bay.

As seen in Table G-7, schooling fish tunas and mackerels, including bonito, pacific mackerel figure prominently in the nearshore recreational catch for the southern California region, comprising approximately 27 percent of the regional catch. Sea basses such as barred sand bass and kelp bass make up 13 percent of the nearshore catch. Similarly, rockfish and scorpionfish comprise 12 percent of the catch.

Table G-7
Contribution of Catch: Southern California[2] Nearshore[1]
Recreational Fisheries from 2004 to 2009

Major (Taxonomic) Fish Group	Percent of Catch
Tunas and Mackerels	27
Sea basses	13
Rockfish and Scorpionfish	12
Herring	11
Croakers	9
Surfperches	9
Silversides	5
Barracuda	<2
Flatfish	<2
Anchovies	<2

Notes: [1] within 3 nautical miles of the shore

[2] San Diego to Los Angeles region as defined in RecFIN database.

Source: Pacific States Marine Fisheries Commission 2010.

There are over 60 different species of rockfish found offshore California, 56 of which are known to reside within the Southern California Bight. Rockfish are spatially localized, preferring high-relief hard-substrate seafloor features. Of the 15 rockfish species that have been formally assessed to date, six species, including four that are important to California anglers (bocaccio, canary rockfish, widow rockfish, and cowcod), have populations at such low levels (estimated at or below 25 percent of the pristine population of each species) that they have been declared overfished by the Pacific Fisheries Management Council. For the recreational fishery, bag limits have been reduced, gear restrictions imposed, seasons closed, and minimum size limits established (CDFG 2001).

Kelp Harvesting and Mariculture

Kelp is harvested both commercially and recreationally throughout southern California. In the Project area, kelp beds are primarily composed of giant kelp (*Macrocystis pyrifera*). Giant kelp occurs from Baja California to Santa Cruz in central California (Druehl, 1970). Populations of the giant kelp commonly form dense patches that are referred to as kelp beds. Wave exposure and rocky substrates generally control their distribution. Except for a specialized population of giant kelp that grows on sand near Santa Barbara, the kelp generally utilizes hard substrates for attachment (North, 1971). Giant kelp can occur in the intertidal zone in protected areas, but the shoreward boundary of giant kelp is largely determined by where the largest waves normally break (Seymore et al., 1989; Graham, 1997). The outer limit of giant kelp beds is largely determined by water clarity (Dean and Deysher, 1983). In turbid waters, the offshore edge of kelp beds occurs at depths of approximately 50 to 60 feet, while in clear waters around the Channel Islands, the offshore edge of kelp beds extend to more than 100 feet (North, 1971).

Giant kelp is very productive. Gerald (1976) reported that productivity varied between 0.4 wet kg/m^2 and 3.0 wet kg/m^2 with an average of 23 wet kg/m^2/year or 102.4 tons/acre/year. Conversely, there are many factors that cause mortality to giant kelp. Storms and large swells that can dislodge plants cause the greatest mortality (Cowen et al., 1982; Dayton et al., 1984; Foster and Schiel, 1985; Dayton, 1985; North, 1986; Seymour et al., 1989). Storms can cause a gradient of damage from single plants and holdfasts to cleared areas several acres in size (Dayton et al., 1984).

Kelp Harvests

Kelp has been harvested commercially along the coast of California since the early 1900s (Scofield, 1959, McPeak and Glantz, 1984; Neushul, 1987; Tarpley and Glantz, 1992). Beginning in 1911, many small companies began harvesting along the coast between Santa Barbara and San Diego. In the early years, kelp was harvested for the extraction of potash and acetone. These chemicals were used to manufacture explosives during World War I. In the 1920s, P.R. Park, Inc. of San Diego began harvesting kelp for use as an additive to livestock and poultry food.

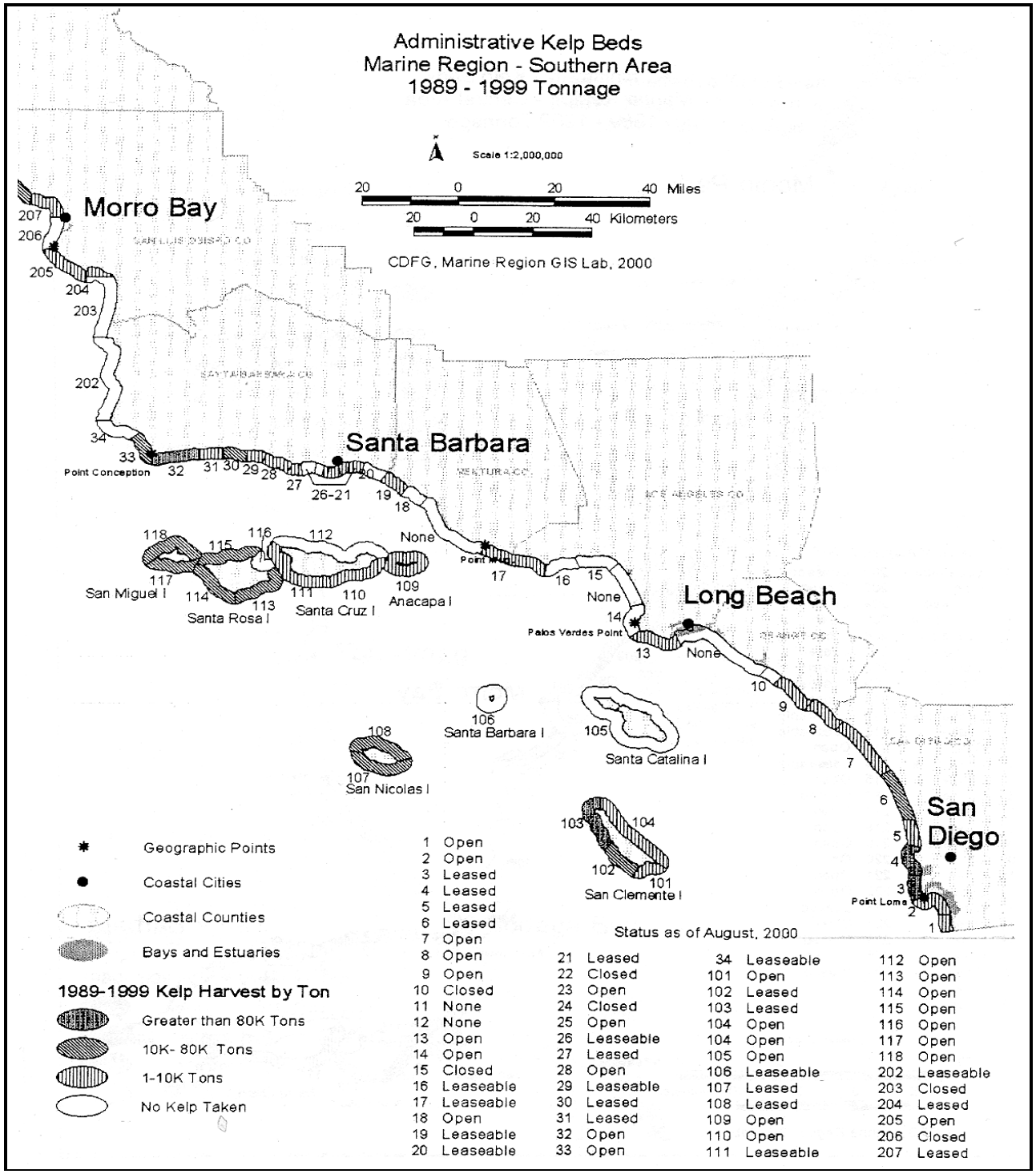
Kelco, now known as ISP Alginates, has harvested and processed giant kelp for the extraction of algin since 1929. Over the years, they developed many applications for algin, which is found in the cells of the kelp. Utilized as a thickening, stabilizing, suspending, and gelling agent, it is used in a wide range of food products, including ice

cream and salad dressings. Industrially, it is used in paper coatings, textile printing and welding-rod coatings. Algin is also used as a thickening and binding agent in pharmaceutical, cosmetic, and dental products. Annual sales of algin products manufactured in California formerly exceeded $40 million (CDFG, 2000).

Commercially harvested kelp is managed in specific beds by the CDFG. In 1931, the CDFG charted and numbered the kelp beds in coastal waters for management purposes (Figure G-3). The numbering system has changed over the years, but presently, there are 74 designated beds from the US-Mexico border to Point Montara in San Mateo County (CDFG, 2000). Kelp beds in the southern California region from the US-Mexico border to Point Arguello are numbered 1 to 34 along the mainland and 101 to 118 around the Channel Islands. Each kelp bed is of varying size and is delineated by true bearings. These kelp beds can produce as much as 1,000 tons (907 metric tons) of kelp per year. The amount of kelp that appears within each bed changes with time. As depicted in the Figure, the few kelp beds lying within the Santa Monica Bay have not generally been harvested on a commercial basis; however, commercially harvested beds exist to the immediate north and south of the Bay as well as on the nearby Channel Islands. These beds could be impacted in the event of an oil spill.

Commercial kelp landings have been monitored since 1915 (Tarpley and Glantz, 1992). Two types of data are collected as part of the monitoring effort. The first type of data consists of landing records that provide the weight, species, collector, and location of kelp harvested. Harvesters are required to provide these data to the CDFG on a monthly basis (CDFG, 2000). The second type of data consists of non-landing statistics that are normally collected by the State agencies, kelp harvesters, academic institutions. For example, ISP Alginates, the primary kelp harvester in California until 2006, conducted aerial resource surveys on a regular basis since 1958. Most of the data they collected, however, are proprietary and unavailable to the public. The CDFG also conducts aerial surveys but annual surveys were intermittent prior to 2002. Since that time, they have been flying annual aerial photo surveys of all of California's kelp beds.

Figure G-3 Location and Yield of Kelp Beds in Southern California



Source: CDFG 2000

The harvest or landing data submitted to the CDFG provide information on the category of plant landed, amount landed, location of harvest, and the name and address of the person or firm to whom the harvest was sold. Statewide kelp harvest data are summarized in Table G-8. Annual California kelp harvest since 1916 has also been published by the National Marine Fisheries Service (NMFS, 2006) and shows a trend of declining harvests since the 1960s and 1970s when more than 120,000 tons were consistently harvested annual basis. As described earlier, harvests from 2006 onward are expected to decline substantially following the relocation of ISP Alginate's manufacturing facilities to Scotland. The unusually low total tonnage reported in Table G-8 during 2002 is inconsistent with the NMFS data, and suggests that the reported CDFG totals are 25,284 tons too low, probably because of underreported harvest in the leased beds. Except for 2001, 2002, and 2003, the total harvest from the leased beds was significantly higher than in open beds, even though there were half as many active leased beds as open beds.

Table G-8
California Kelp Harvest (*Macrocystis pyrifera*) for 1995-2005

Year	Open Beds	Leased Beds	Total Tons
1995	4,217	73,536	77,753
1996	13,537	64,924	78,461
1997	12,366	32,977	45,343
1998	2,090	23,223	25,313
1999	8,076	34,135	42,211
2000	14,506	27,438	41,944
2001	23,035	17,262	40,297
2002	18,953	7,631	26,584
2003	25,111	25,633	50,744
2004	8,185	33,986	42,171
2005	26,463	46,142	72,605

Kelp Harvesting Vessels

The vessels used for harvesting commercial kelp beds range in length from 140 to 180 feet. The majority of the length of the vessel is comprised of the bin for holding the cut kelp (CDFG, 2000). Kelp is cut by reciprocating blades mounted at the base of a conveyor system (drapers) located at the stern end of the ship. The draper system is lowered into the water to a depth of 3 feet, and the harvest ship moves stern-first through the kelp bed. As the kelp is cut, it is brought aboard on the conveyor system and deposited in the bin. The harvest vessels can carry as much as 600 tons of kelp, which can all be collected in a single day (CDFG, 2000). The large harvest vessels have a draft of approximately 12 feet and work at water depths greater than 30 feet.

Kelp harvesting vessels used by abalone aquaculturists are smaller than those used by the commercial harvesters. The smaller vessels are capable of working in shallower waters because of their shallow draft. They typically carry between 15 and 25 tons of kelp. Kelp is also harvested by hand from smaller boats to supply abalone farms. It is either cut at the surface using a knife attached to a pole, or cut beneath the water

surface by a diver. The cut fronds are bundled together and pulled aboard the boat by hand.

Recreational Kelp Harvesting

Very little information is available on the quantity of kelp harvested for recreational purposes. However, several native American Indian tribes and Asian groups utilize kelp as both a food and medicinal source. Recreational harvesting of kelp usually occurs from shore, and consists of collecting drift kelp that has washed up on the beach or fresh kelp that is harvested during low tides. In addition to giant kelp, local Asian groups also harvest seaweeds such as *Porphyra* spp. and *Ulva* spp. in the Project area during spring low tides. These algae are utilized as a food source. Other recreational uses of kelp include its use as an ingredient in the firing of ceramics and by gardeners for use as compost (CDFG, 2000). Nevertheless, recreational kelp use in the region is limited; it has been estimated that less than 25 tons of giant kelp are collected annually by recreational users (CDFG, 2000).